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Propulsion system options for a Potential Sample Return Lander(SRL) for Mars

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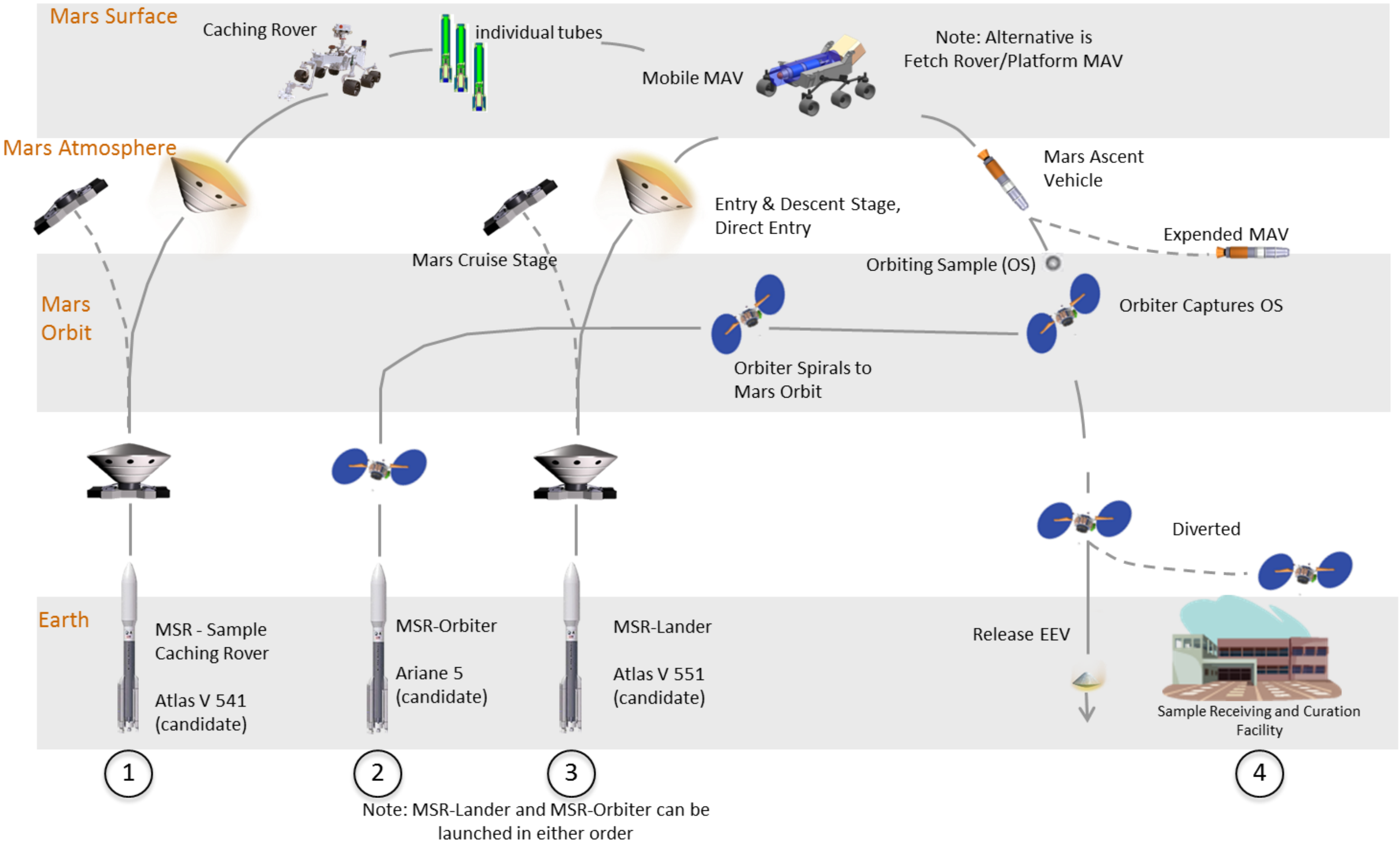
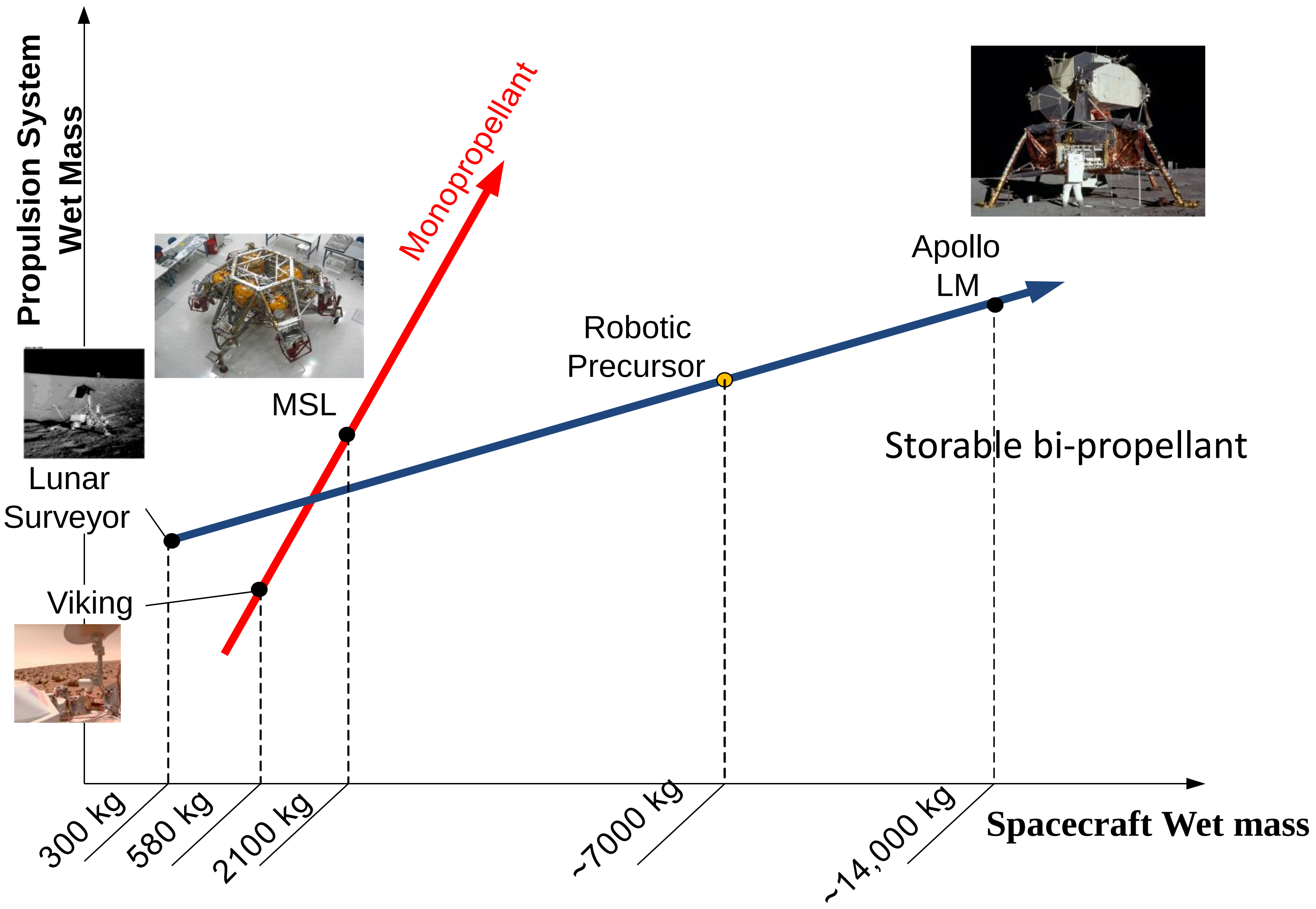


A Notional three mission architecture approach for MSR

Potential Propulsion Options for SRL

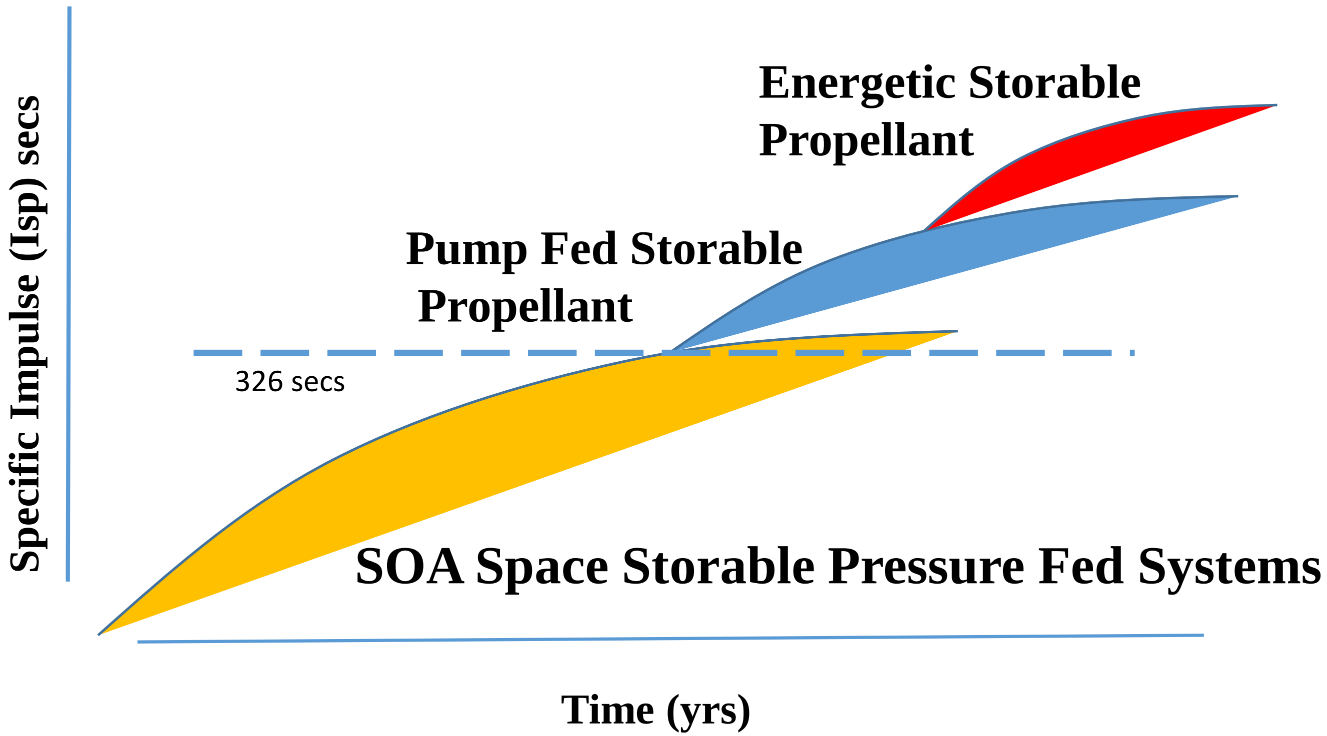
- Evaluation based on delta-V need
- If payload < 1200 kg conventional propulsion with parachute
    - Heritage monopropellant
    - Pressure fed throttleable bi-propellant
- If payload >1200 kg Supersonic Retro Propulsion (SRP) , no parachute
    - Electrically Driven Pump Fed Propulsion (EDPF)

Monopropellant and Bi-propellant History



Historical View of Monopropellant and Bi-propellant Propulsion Systems

Where is the SOA for Bi-propellant propulsion

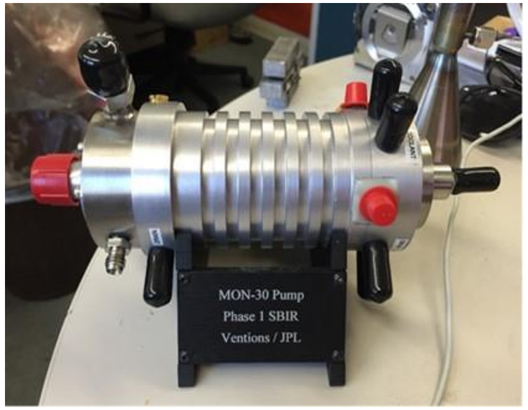


SOA performance for Storable Bi-propellant Engines.

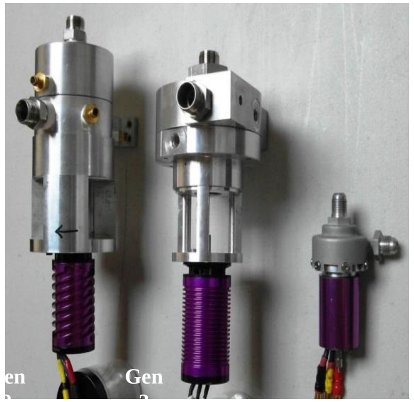
EDPF Developments

Case	Propellant	Description
Monopropellant	Hydrazine	Pressure Fed , Regulated helium pressurization and N engines (3500N class) with throttle valves.
EDPF Monopropellant	Hydrazine	Pump Fed , regulated helium pressurization and N engines (3500N) class)
SOA Bi-propellant	NTO/MMH	Pressure Fed, Regulated helium pressurization and N engines with throttle valves
EDPF Bi-propellant	NTO/MMH	Pump Fed, regulated helium pressurization and N engines

Cases considered in Study

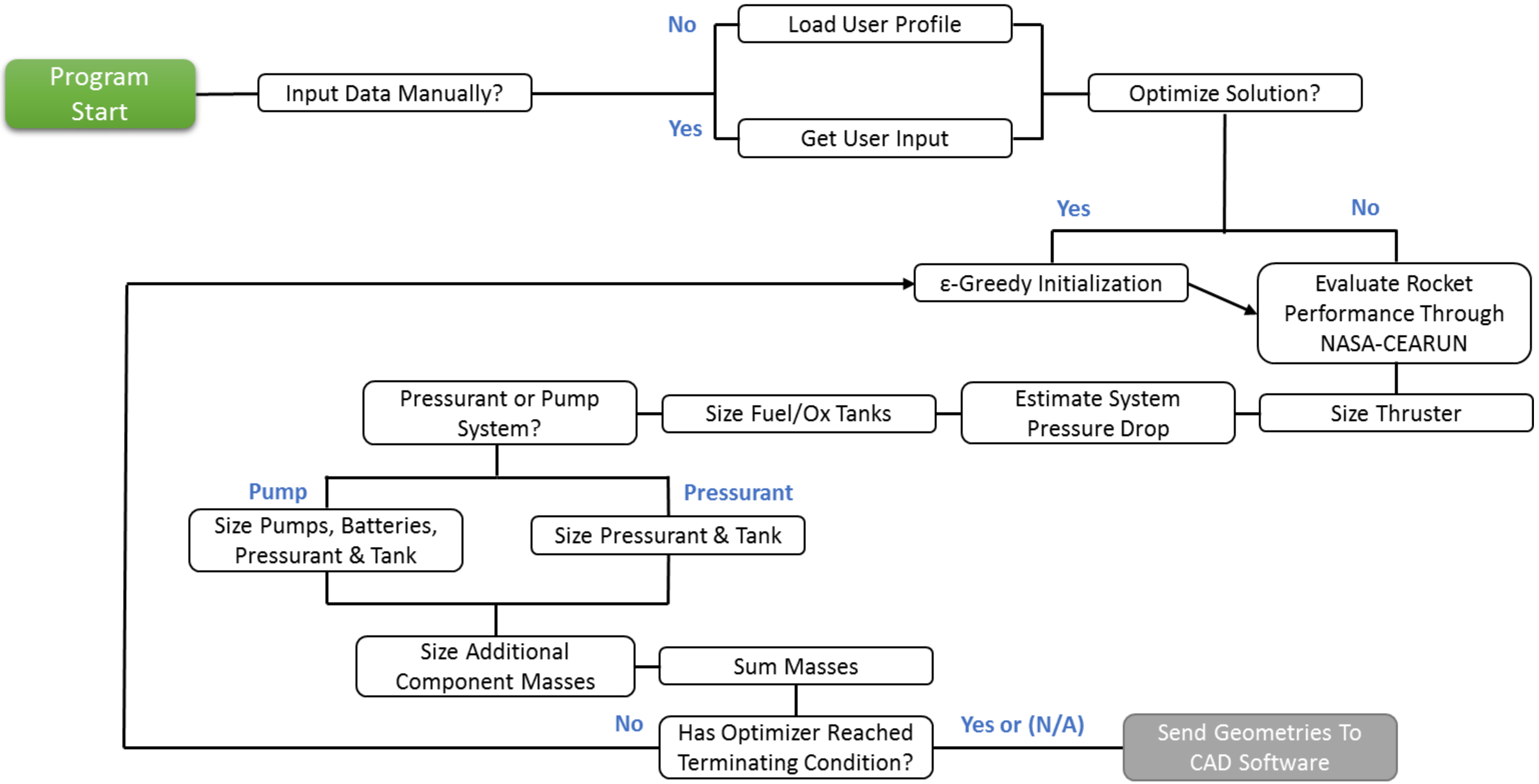


Mon-30 EDPF

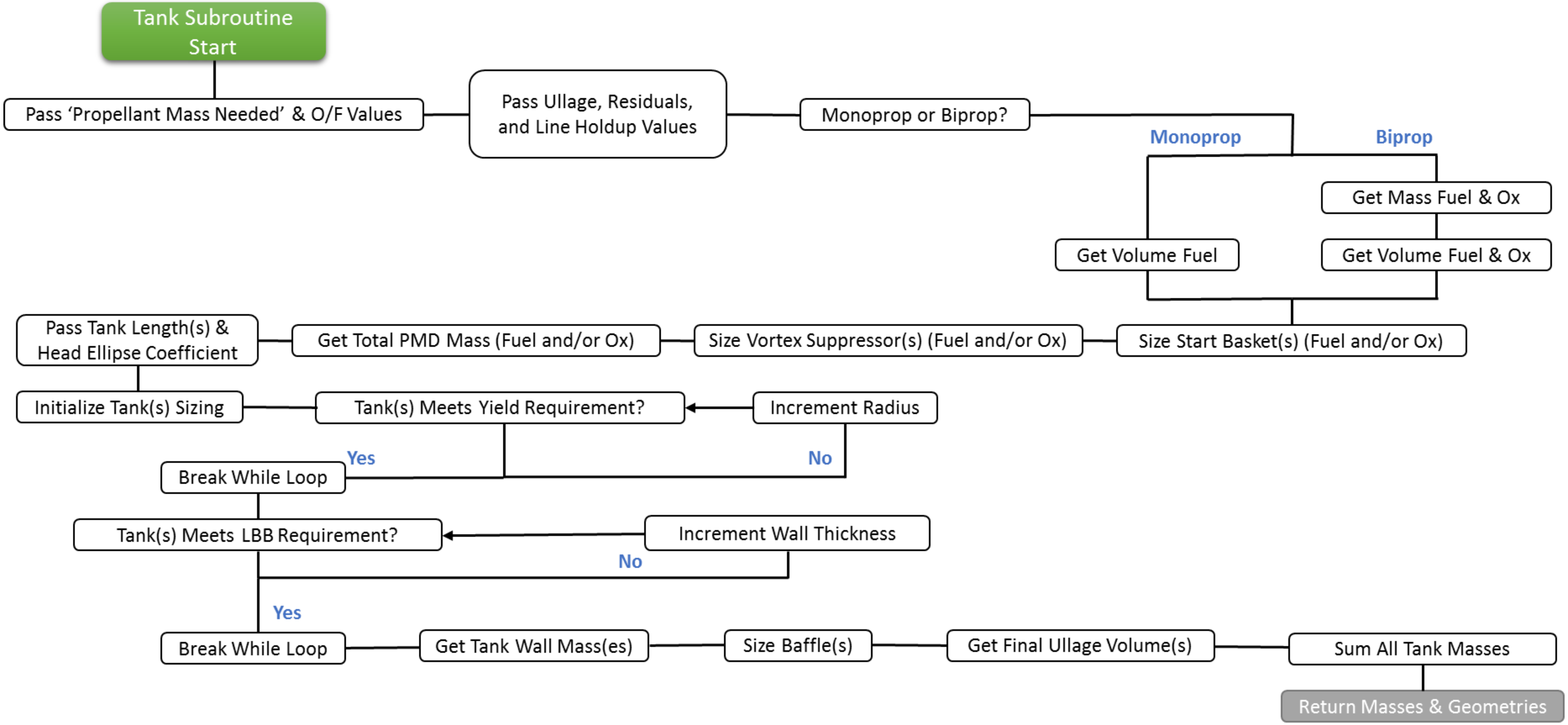


Examples of Ventions LLC EDPF development

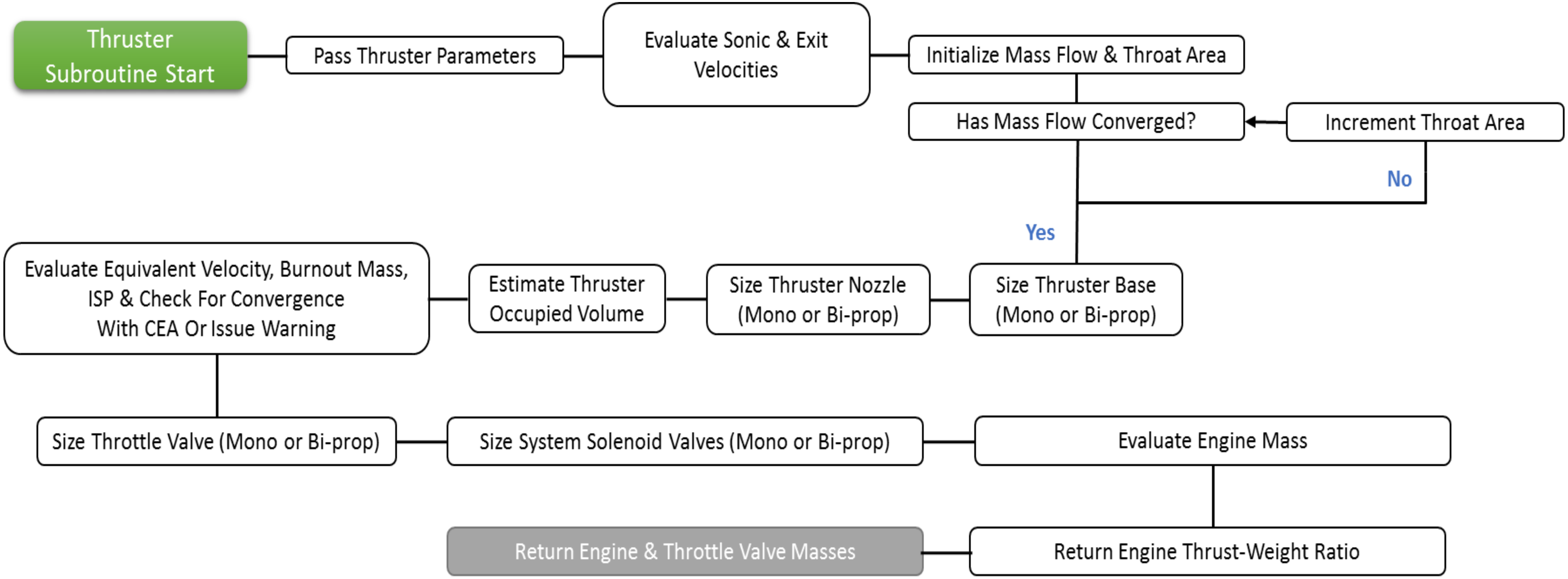
Logical Flow – Overall Program:



Logical Flow – Tank Subroutine:



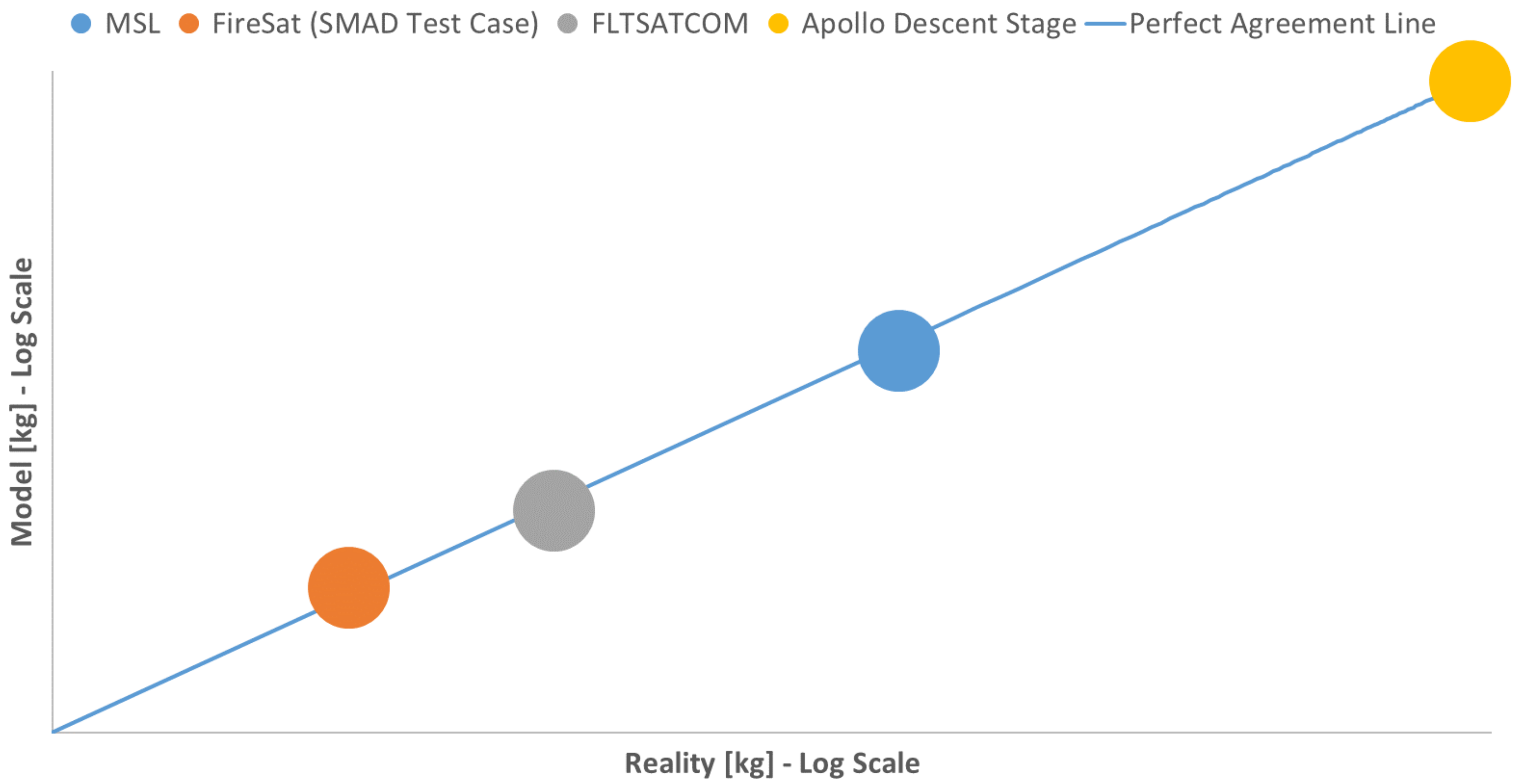
Logical Flow – Engine Subroutine:



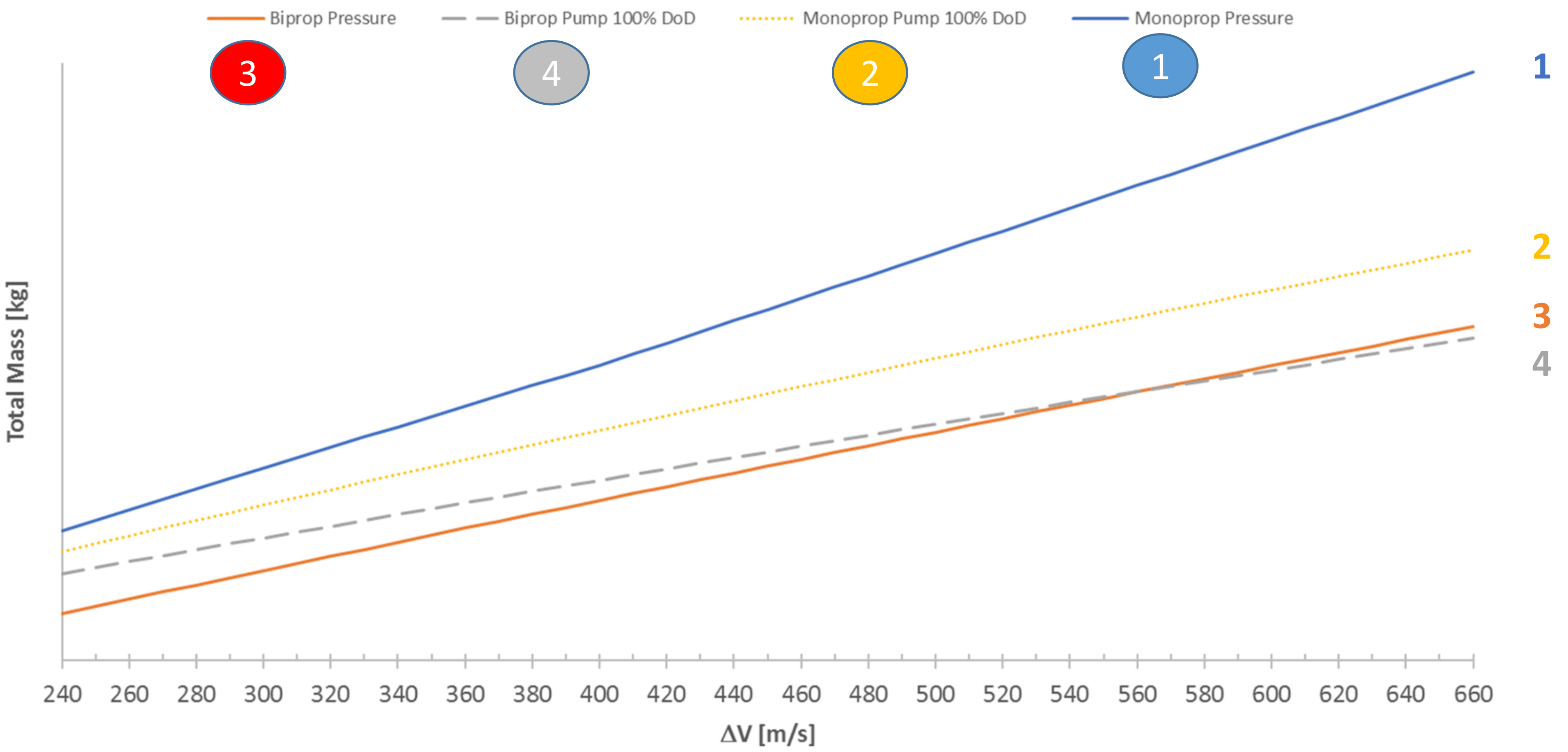
Optimization Choices

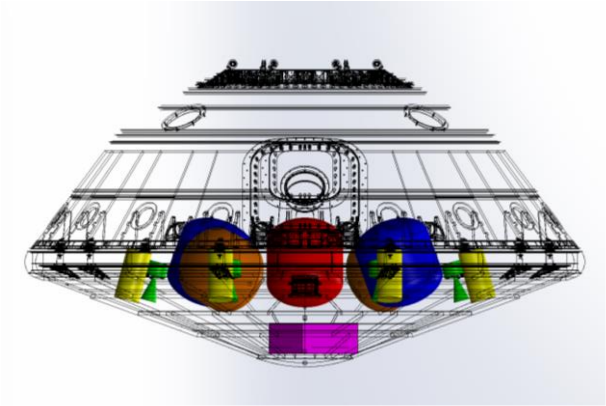
- Chamber pressure
- Nozzle Area Ratio
- O/F Ratio
- Cant Angle
- Number of Engines
- Number of Ox Tanks
- Number of Fuel Tanks
- Number of Pressurant Tanks

Predictions Versus Actuals*: -2 ± 8 % difference across all four comparisons



Delta-V Versus System Mass:

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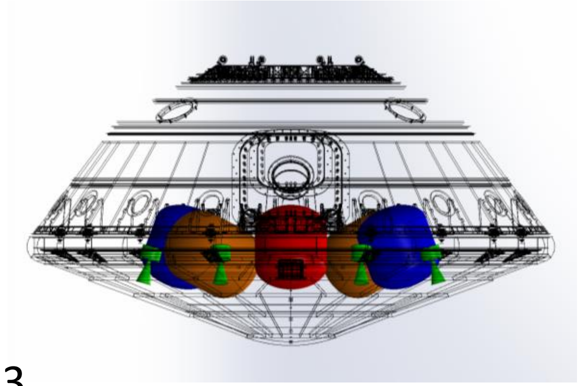
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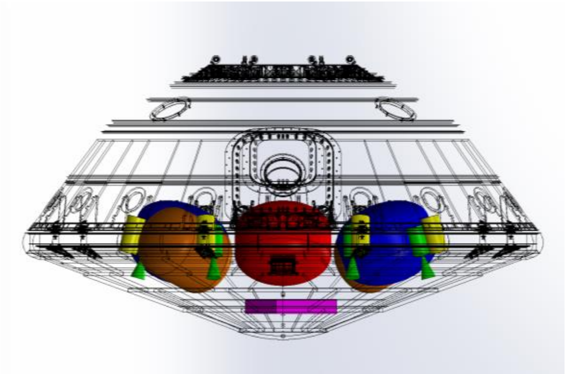
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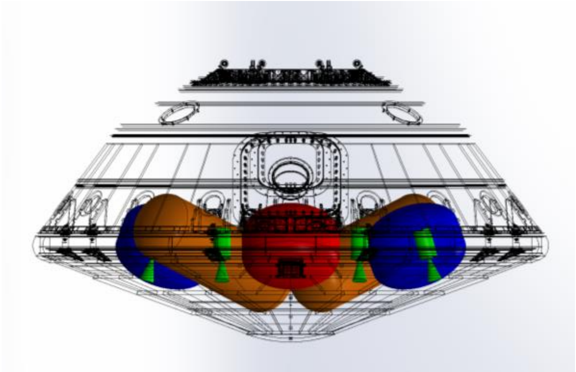
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References

- Epsilon-Greedy: Kochenderfer, M. J., “Decision Making Under Uncertainty: Theory and Application”, *MIT Press.*, 2015
- Test Cases: James R. Wertz & Wiley J. Larson, “Space Mission Analysis And Design”, *Microcosm Press*, Third Edition, 2003